



**DEPARTMENT of AGRICULTURE
and NATURAL RESOURCES**

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**RECOMMENDATION OF CHIEF ENGINEER FOR WATER PERMIT
APPLICATION NO. 8767-3, Knife River**

Pursuant to SDCL 46-2A-2, the following is the recommendation of the Chief Engineer, Water Rights Program, Department of Agriculture and Natural Resources concerning Water Permit Application No. 8767-3, Knife River, c/o Colin Chatterton, 1500 N Sweetman Place, Sioux Falls SD 57107.

The Chief Engineer is recommending APPROVAL of Application No. 8767-3 because 1) there is reasonable probability that there is unappropriated water available for the applicant's proposed use, 2) the proposed diversion can be developed without unlawful impairment of existing domestic water uses and water rights, 3) the proposed use is a beneficial use and 4) it is in the public interest as it pertains to matters of public interest within the regulatory authority of the Water Management Board with the following qualifications:

1. The sand and gravel operation will excavate into and pump from the Big Sioux:South aquifer. This operation will be located near domestic wells and other wells which may obtain water from the same aquifer. The Permit holder shall control withdrawals so there is not a reduction of needed water supplies in adequate domestic wells or in adequate wells having prior water rights.
2. The permit holder shall report to the Chief Engineer annually the amount of water withdrawn from the Big Sioux:South aquifer.
3. Water Permit No. 8767-3 appropriates up to 1,200 acre feet of water annually.

See report on application for additional information.

Eric Gronlund, Chief Engineer
July 26, 2023

Report to the Chief Engineer
Water Permit Application No. 8767-3
Knife River
July 26, 2023

Water Permit Application No. 8767-3 proposes to appropriate up to 1,200 acre-feet of water annually at a maximum instantaneous diversion rate of 2.22 cubic feet of water per second (cfs) from an open pit for mining sand and gravel to be completed into the Big Sioux: South aquifer. The diversion point is located in the Lot 6 (SE $\frac{1}{4}$ SW $\frac{1}{4}$) of Section 1 for the dewatering of an open pit for industrial mining of sand and gravel located in SE $\frac{1}{4}$ SW $\frac{1}{4}$ of Section 1, all in T95N-R48W. The site is located in Union County approximately 16 miles east of Beresford, South Dakota.

AQUIFER: Big Sioux: South (BS:S)

HYDROGEOLOGY:

The Big Sioux aquifer underlies the flood plain of the Big Sioux River with the South management unit underlying most of eastern Lincoln and Union Counties, and a portion of northeast Minnehaha County (Niehus, 1994; Hedges et al., 1992). The areal extent of the Big Sioux: South aquifer is provided in Table 1. The Big Sioux: South aquifer is largely composed of fine to coarse, poorly sorted sand and fine to coarse pebble gravel with thin, interbedded clay and till layers in some areas (Lindgren and Niehus, 1992). The Big Sioux: South aquifer has an average depth below land surface of approximately 10 feet for unconfined conditions, which is the prevailing condition for a majority of the management unit (Hedges et al., 1985; Lindgren and Niehus, 1994). Confined conditions can exist when overlaid by glacial till (Lindgren and Niehus, 1992). The aquifer also overlays a glacial till confining unit, consisting of a brownish-gray silty, clay-rich matrix (Davis, 2019). Average thickness of aquifer materials in the Big Sioux: South aquifer in Lincoln and Union counties ranges between approximately 22 to 28 feet (Lindgren and Niehus, 1994; Niehus and Thompson, 1998), and can reach maximum thicknesses of approximately 70 feet (Niehus and Thompson, 1998).

Since this is an open pit that incises the aquifer, no water well or test hole completion report was submitted with Water Permit Application No. 8767-3. Well completion reports and lithologic logs on file for the Big Sioux: South aquifer within approximately 1.5 miles of the proposed diversion point show that majority of the wells are completed into unconfined areas of the aquifer, with static water levels ranging from approximately 6 to 15 feet below top of casing, saturated thickness ranging from approximately 18 to 24 feet, and depth to top of aquifer ranging from approximately 1.5 to 7 feet below land surface (SDGS, 2023; Water Rights, 2023d). Well completion reports on file for wells completed into unconfined portions of the aquifer tend to be closer to the floodplain of the Big Sioux River and the aquifer is generally overlain with yellow clay or topsoil (Water Rights, 2023d).

Based on the well completion reports and lithologic well logs on file for the Big Sioux: South aquifer near the proposed diversion point, the proposed diversion point for Water Permit Application No. 8767-3 will likely be under unconfined conditions. Figure 1 shows the approximate delineation of the Big Sioux: South aquifer and location of the proposed diversion point.

Table 1. Estimated areal extent of Big Sioux: South aquifer in Lincoln, Minnehaha, and Union Counties, and recoverable water in storage (Hedges et al., 1982).

County	Areal Extent (acres)	Recoverable Water in Storage (acre-feet)
Lincoln	15,600	70,200
Minnehaha	17,200	20,640
Union	16,200	72,900
Total	49,000	163,740

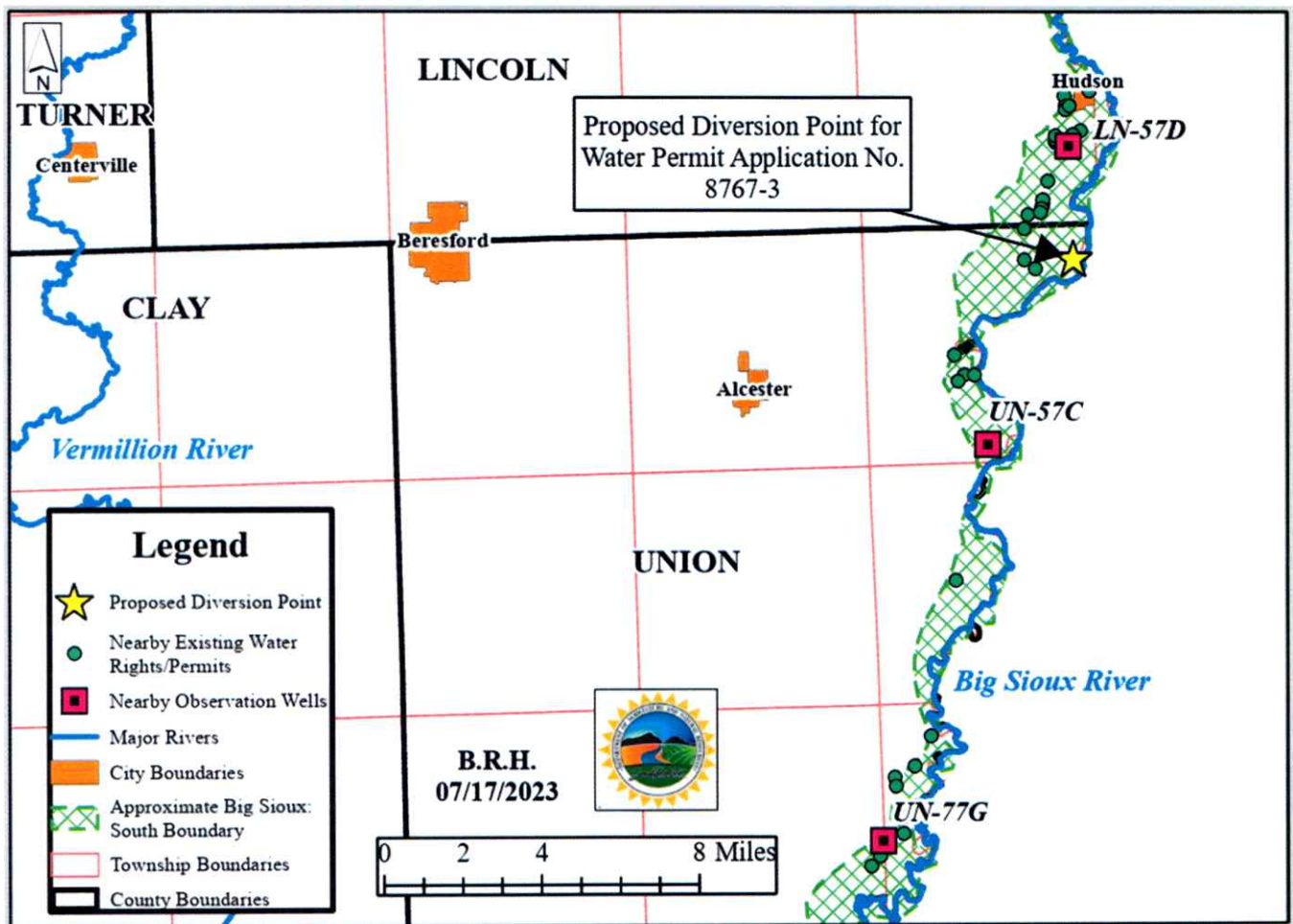


Figure 1: Map of the approximate Big Sioux: South aquifer areal extent in portions of Lincoln and Union counties (modified from Hedges et al., 1982), the location of the proposed diversion point for Water Permit No. 8767-3, nearby observation wells, and existing water rights/permits in the Big Sioux: South aquifer (Water Rights, 2023b and 2023c).

South Dakota Codified Law (SDCL) 46-2A-9

Pursuant to SDCL 46-2A-9, "A permit to appropriate water may be issued only if there is a reasonable probability that there is unappropriated water available for the applicant's proposed use, that the diversion point can be developed without unlawful impairment of existing domestic water uses and water rights, and that the proposed use is a beneficial use and in the public interest as it pertains to matters of public interest within the regulatory authority of the Water Management Board as defined by SDCL 46-2-9 and 46-2-11." This report will address the availability of unappropriated water and the potential for unlawful impairment of existing domestic water uses and water rights within the Big Sioux: South aquifer.

WATER AVAILABILITY:

Water Permit Application No. 8767-3 proposes to appropriate water from the Big Sioux: South aquifer. The probability of unappropriated water being available from the aquifer can be evaluated by considering SDCL 46-6-3.1, which requires that:

"No application to appropriate groundwater may be approved if, according to the best information reasonably available, it is probable that the quantity of water withdrawn annually from a groundwater source will exceed the quantity of the average estimated annual recharge of water to the groundwater source. An application may be approved, however, for withdrawals of groundwater from any groundwater formation older than or stratigraphically lower than the Greenhorn formation in excess of the average estimated annual recharge for use by water distribution systems."

Water Permit Application No. 8767-3 does not involve a public water system as defined by SDCL 46-1-6 (17) and the aquifer is above the Greenhorn formation (Fahrenbach et al., 2010). Therefore, recharge and withdrawal must be considered. The methods of assessment are a hydrologic budget with quantified values of recharge and withdrawal, and observation well analysis.

HYDROLOGIC BUDGET:

Recharge

Recharge to the Big Sioux: South aquifer in Lincoln and Union Counties is mainly through infiltration of precipitation, groundwater recharge from glacial aquifers including the Shindler aquifer in northeast Lincoln County and the Newton Hills and Brule Creek aquifers in southeastern Lincoln County, among others, and the underlying Dakota bedrock aquifer. Surface water features including the Big Sioux and Missouri Rivers may recharge the Big Sioux: South during high stages (Niehus, 1994 and 1997). Streamflow of the Big Sioux River is directly related to seasonal variations in precipitation and evapotranspiration (Niehus, 1994).

Previously published work of hydrologic properties include Niehus and Thompson (1998), who published groundwater flow models of the Big Sioux aquifer in Lincoln, Union, and a portion of Minnehaha Counties to determine recharge rates. Hedges et al. (1985) also published recharge rates for the Big Sioux: South aquifer using observation well data. For both publications of recharge rate, the same method was used, which was determining an average water-level rise for recorded years of measurement (inches/year), and then multiplying that by a specific yield value, 0.20 and 0.15,

respectively. The estimated average recharge rates were then 7.54 inches/year and 4.1 inches/year, respectively. This gives a volumetric recharge rate range of 16,742 acre-feet/year to 30,788 acre-feet/year, using the areal extent of the Big Sioux: South aquifer estimated by Hedges et al. (1982) (Table 1).

Discharge

Discharge from the Big Sioux: South aquifer is by evapotranspiration where the aquifer is close to land surface, outflow to the Big Sioux River and Missouri aquifer, and withdrawals from wells by water rights/permits and domestic wells (Niehus, 1994). Discharge occurs through seepage to the Big Sioux River when the river stage is lower than the water table in the aquifer (Lindgren and Niehus, 1994). The Big Sioux: South aquifer may also have outflow to the Newtown Hills aquifer depending on the relative potentiometric elevations (Niehus, 1994).

Currently, there are 65 water rights/permits (irrigation and non-irrigation use) that are authorized to appropriate water from the Big Sioux: South aquifer (Water Rights, 2023c). Table 2 summarizes the 27 non-irrigation water rights/permits authorized to appropriate water from the Big Sioux: South aquifer with the estimated annual use for each water right/permit as determined by their permitted maximum diversion rate or annual volume. Non-irrigation water rights/permits that are limited only by an instantaneous diversion rate are assumed to be pumping 60% of the time at the respective permitted diversion rates. Non-irrigation water rights/permits limited by an annual volume are assumed to withdraw their entire respective annual volume limitation. These are standard assumptions used by the DANR-Water Rights Program for estimating annual withdrawals from non-irrigation appropriations from an aquifer (Water Rights, 2023c). Two municipal water rights were identified as being connected to a rural water system and likely maintain their wells for standby purposes (Water Rights, 2023c); the average annual water use for these water rights has been estimated to be zero acre-feet/year as indicated by an asterisk on Table 2. There are two municipal future use water permits that have been included on Table 2 for the City of Brandon with the volume of water currently reserved by the respective permits. For the hydrologic budget, it is assumed that the future use permits will be fully developed from the Big Sioux: South aquifer. Overall, the estimated average annual withdrawal rate from the Big Sioux: South aquifer by the non-irrigation water rights/permits (including future use water permits) is approximately 8,808 acre-feet/year (Table 2) (Water Rights, 2023c).

Table 2: Estimated annual use for the non-irrigation water rights/permits authorized to divert water from the Big Sioux: South aquifer (Water Rights, 2023c).

Permit No.	Name	County	Status	Use	Authorized Diversion Rate (cfs)	Permitted Volume (acre-feet)	Estimated Volume (acre-feet/year)
1139-3	Town of Hudson	LN	LC	MUN	0.71	N/A	0*
1262B-3	City of Canton	LN	LC	MUN	0.22	N/A	95.6
1618-3	Knife River	MA	LC	COM	1	N/A	434.4
1908-3	Valley View Mobile Home Park	MA	LC	COM	0.1	N/A	43.4
3454-3	Lincoln County RWS	LN	LC	RWS	0.5	N/A	217.2
4002-3	City of Brandon	MA	FU	MUN	4	N/A	685
4792-3	Everist Inc.	MA	LC	COM	1	N/A	434.4
4842-3	Brandon Materials Co.	MA	LC	IND	1.11	N/A	482.2
4883-3	City of Harrisburg	LN	LC	MUN	0.5	N/A	0*
5133-3	Knife River	MA	LC	COM	0.04	N/A	17.4
5242-3	City of Sioux Falls	MA	LC	IND	1.56	110	110
5517-3	Zoological Society of Sioux Falls	MA	LC	COM	0.03	N/A	13.0
5591-3	Amoco Corporation	MA	LC	GWR	0.16	N/A	69.5
5684-3	Great Plains Zoo/Museum	MA	LC	COM	0.067	N/A	29.1
5755-3	Amoco Corporation	MA	LC	GWR	0.24	N/A	104.3
5842-3	Michael Coughlin	MA	LC	COM	0.02	N/A	8.7
5869-3	City of Brandon	MA	LC	MUN	0.78	N/A	338.8
6093-3	Lyon & Sioux RWS Inc.	LN	LC	RWS	1.33	530	530
6423-3	Poet Biorefining-Hudson LLC	LN	LC	IND	1.78	1,000	1,000
6696-3	City of Brandon	MA	FU	MUN	N/A	1,227.7	1,227.7
6924-3	Lincoln County RWS	LN	PE	RWS	2.5	N/A	1,086
7181-3	City of Brandon	MA	LC	MUN	N/A	N/A	0
7203-3	Lincoln County RWS	LN	PE	RWS	N/A	N/A	0
8366-3	Gage Brothers	MA	PE	IND	0.44	10.4	10.4
8462-3	Ace Ready Mix	MA	LC	IND	0.44	79.8	79.8
8526-3	Everist Inc.	MA	PE	IND	3.33	1,166	1,166
8569-3	Everist Inc.	MA	PE	IND	1.44	N/A	625.5
LN: Lincoln County; MA: Minnehaha County; LC: Licensed Water Right; PE: Permitted Water Right; MUN: Municipal; COM: Commercial; GWR: Groundwater Remediation; IND: Industrial; RWS: Rural Water System; *Identified as being connected to Rural Water System						TOTAL:	8,808

Irrigation water rights/permits have been required to report their annual usage on an irrigation questionnaire since 1979. The estimated average annual withdrawal rate for the Big Sioux: South aquifer for irrigation water rights/permits that have reported over the period of record (1979 to 2021) is approximately 1,138 acre-feet/year (Table 3) (Water Rights, 2023a). To reflect the current development of irrigation water rights/permits more accurately, the average annual withdrawal rate for irrigation applications from 2012 to 2021 is approximately 1,532 acre-feet/year (Table 3) (Water Rights, 2023a).

Currently, there are 38 irrigation water rights/permits authorized to appropriate water from the Big Sioux: South aquifer (Water Rights, 2023c). As of July of 2023, water right/permit Nos. 686-3, 4888A-3, and 8546-3 are established but not included on the 2021 IQ survey, while water right/permit Nos. 4888-3, 2256-3, and 6551-3 have been incorporated or cancelled since the 2021 IQ survey (Water Rights, 2023a and 2023c). The volume of water from irrigation water rights/permits withdrawn in 2022 from the Big Sioux: South aquifer is not yet available (Water Rights, 2023a). If the average annual withdrawal rates from the irrigation permits within the Big Sioux: South aquifer increased in 2022, the full extent of that increase will be unknown until the irrigation questionnaire data is available.

There are domestic wells completed into the Big Sioux: South aquifer that do not require a water right/permit, so the withdrawal amount from those wells is unknown (Water Rights, 2023d). Due to their relatively low diversion rates, withdrawals from domestic wells are generally not considered to be a significant portion of the hydrologic budget. Additionally, rural water systems have been developed in areas where the Big Sioux: South aquifer is the uppermost aquifer available, and it is likely that some domestic users have transitioned to rural water. Therefore, the quantity of water withdrawn by domestic wells is estimated to be negligible to the hydrologic budget for the aquifer.

Table 3: Reported historic irrigation use from the Big Sioux: South aquifer and summary statistics from 1979 to 2021 (Water Rights, 2023a).

Year	No. of Permits Reporting	Reported Volume Pumped (acre-feet)
1979	29	603
1980	29	575
1981	30	885
1982	22	468
1983	26	648.5
1984	25	805.5
1985	25	988
1986	26	874
1987	26	1,007
1988	27	2,112
1989	23	1,308
1990	26	1,188
1991	27	729
1992	28	206
1993	30	165.5
1994	29	898
1995	30	895
1996	30	957
1997	29	1,311
1998	29	818
1999	30	1,025
2000	31	1,352
2001	31	1,002
2002	32	1,193
2003	29	1,727
2004	29	1,280
2005	30	1,541
2006	30	1,709
2007	29	1,918
2008	30	1,157
2009	31	419.5
2010	32	139
2011	31	1,722
2012	32	2,403
2013	36	2,191
2014	36	1,012
2015	36	1,333
2016	37	1,494
2017	37	2,140
2018	37	479
2019	37	336
2020	36	1,733
2021	38	2,194
Max	38	2,403
Min	22	139
Avg (1979-2021)	30	1,138
Avg (2012-2021)	36	1,532

Hydrologic Budget Summary

The estimated average annual recharge rate to the Big Sioux: South aquifer is approximately 16,742 to 30,788 acre-feet/year (Hedges, 1982 and 1985; Niehus and Thompson, 1998). The estimated average annual withdrawal rate from the Big Sioux: South aquifer is approximately 11,540 acre-feet per year (non-irrigation: 8,808 acre-feet/year; irrigation (2012 to 2021 IQ survey average): 1,532 acre-feet/year; Water Permit Application No. 8767-3 (if approved, assuming to withdraw entire volume limitation: 1,200 acre-feet/year). Based on the hydrologic budget, there is a reasonable probability unappropriated water is available from the Big Sioux: South aquifer for the proposed appropriation.

OBSERVATION WELL DATA:

Administrative Rule of South Dakota (ARSD) 74:02:05:07 requires that the Water Management Board shall rely upon the record of observation well measurements in addition to other data to determine that the quantity of water withdrawn annually from the aquifer does not exceed the estimated average annual recharge of the aquifer.

Observation wells provide data on how the aquifer reacts to regional climatic conditions and local pumping. The DNR-Water Rights Program monitors 20 observation wells completed into the Big Sioux: South aquifer (Water Rights, 2023b). The three closest observation wells to the proposed diversion point with adequate data (as shown in Figure 1) are LN-57D (approximately 2.9 miles north), UN-57C (approximately 5.2 miles southwest), and UN-77G (approximately 15.6 miles southwest) (Water Rights, 2023b). These observation wells are generally representative of the behavior of the Big Sioux: South aquifer. Hydrographs of observation wells are constructed by measuring the static water level from the top of the well casing over a period of record. The hydrographs of these nearest observation wells are displayed in Figures 2 to 4 (Water Rights, 2023b).

The overall trend for the hydrographs of the nearest observation wells to the proposed diversion point display stable to a slight increase of water levels. The hydrographs indicate that the Big Sioux: South aquifer responds well to climatic conditions because water levels are rising during wetter periods and declining to a stable water level during drier periods. Additionally, the water levels in the observation wells display that the aquifer returns to pre-pumped conditions between irrigation seasons. Aquifer recovery indicates that climatic conditions and therefore, recharge to and natural discharges from the aquifer govern the long-term fluctuations of water levels in the aquifer rather than the impacts of pumping from the Big Sioux: South aquifer. Therefore, observation well hydrographs demonstrate that unappropriated water is available for the proposed appropriation.

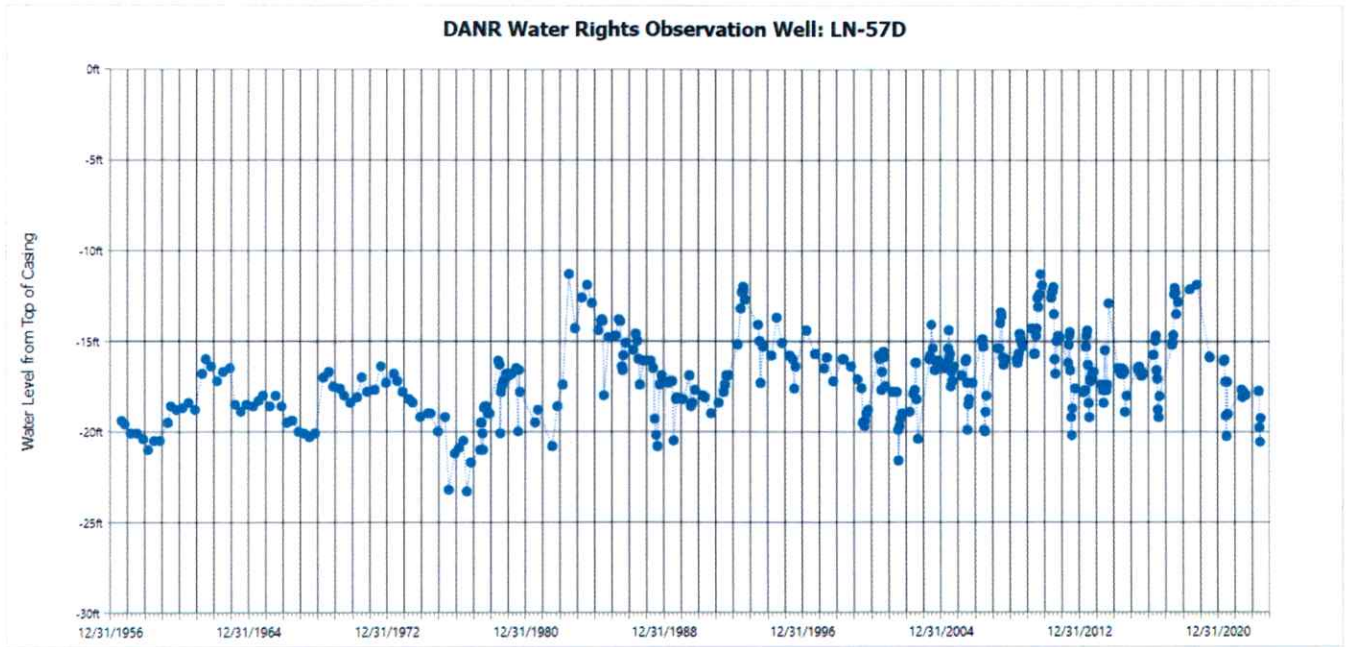


Figure 2: Hydrograph for observation well LN-57D (Water Rights, 2023b).

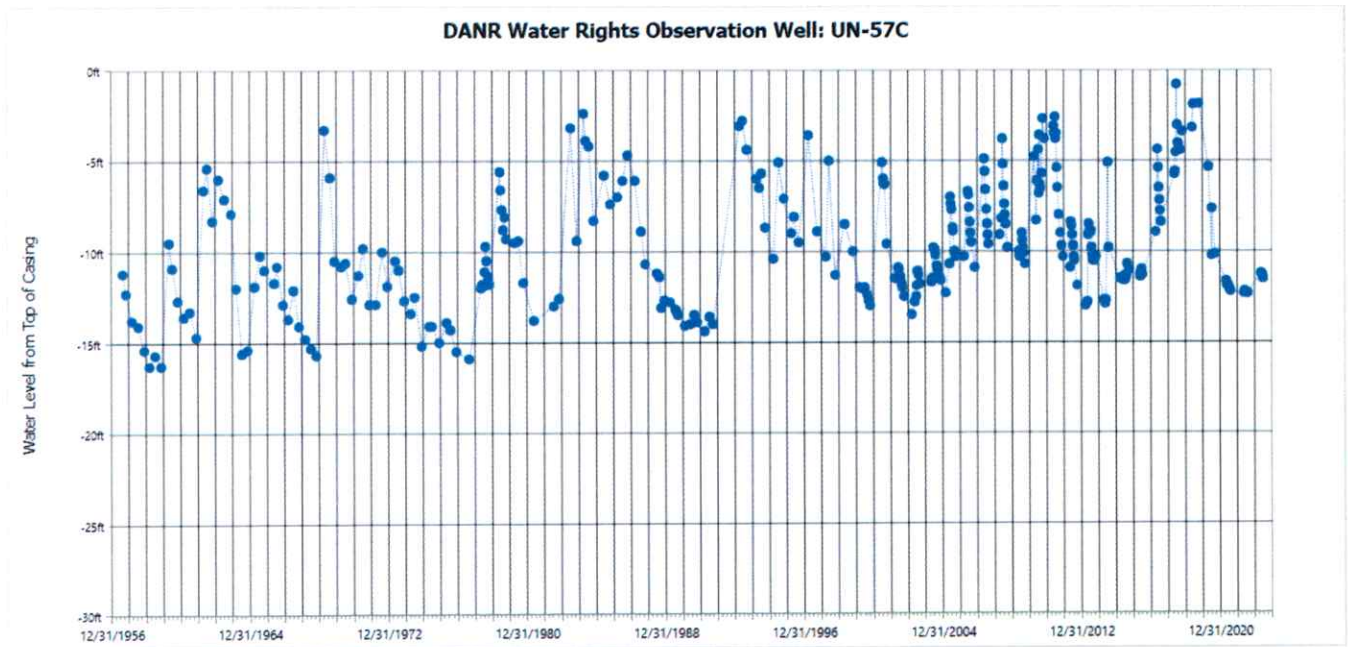


Figure 3: Hydrograph for observation well UN-57C (Water Rights, 2023b).

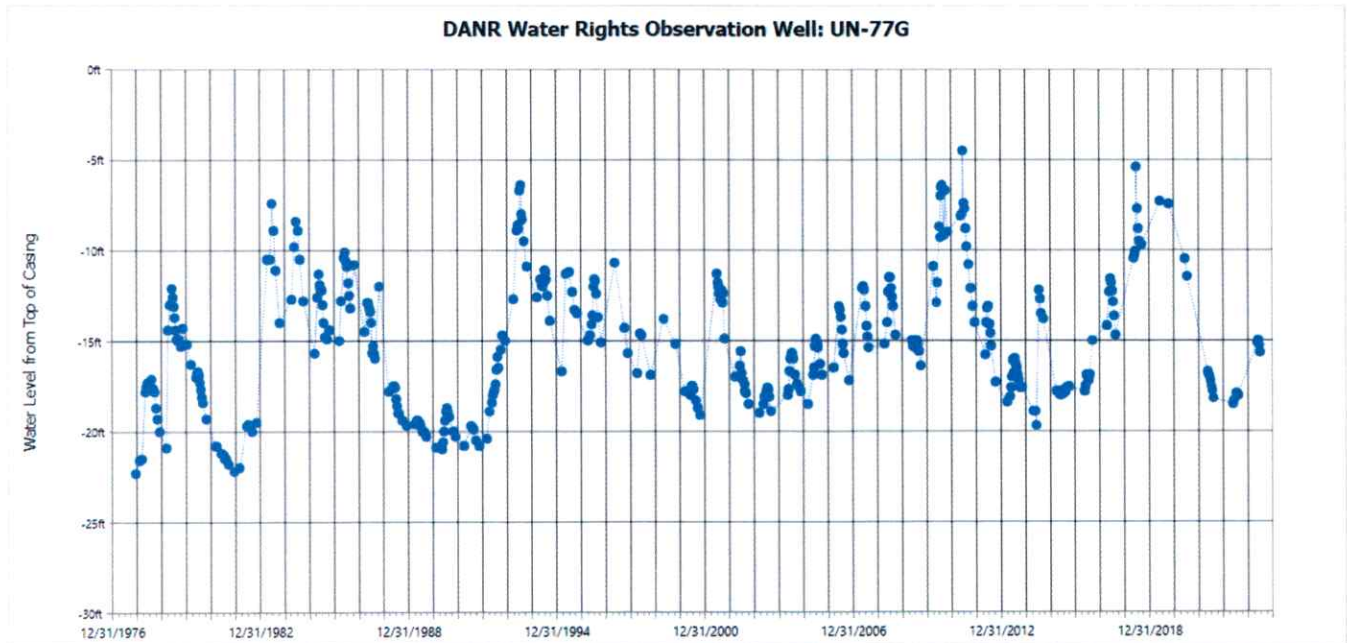


Figure 4: Hydrograph for observation well UN-77G (Water Rights, 2023b).

POTENTIAL FOR UNLAWFUL IMPAIRMENT OF EXISTING WATER RIGHTS:

Currently, there are 65 water rights/permits authorized to appropriate water from the Big Sioux: South aquifer (Water Rights, 2023c). The closest water right/permit to the proposed diversion point is Water Permit No. 4888A-3, which is held by Jett Boyer. The diversion point for Water Permit No. 4888A-3 is located approximately one mile west of the proposed diversion point for this application (Table 4) (Figure 5) (Water Rights, 2023c).

There are domestic wells on file with the DANR-Water Rights Program that are completed into the Big Sioux: South aquifer, with the closest domestic well on file (not held by the applicant) approximately 0.75 miles west of the proposed diversion point (Water Rights, 2023d). There could potentially be other domestic wells completed into the Big Sioux: South aquifer near the proposed diversion point that are not on file with the DANR-Water Rights Program. The location of the domestic wells is based on the location provided at the time of completion by the well driller.

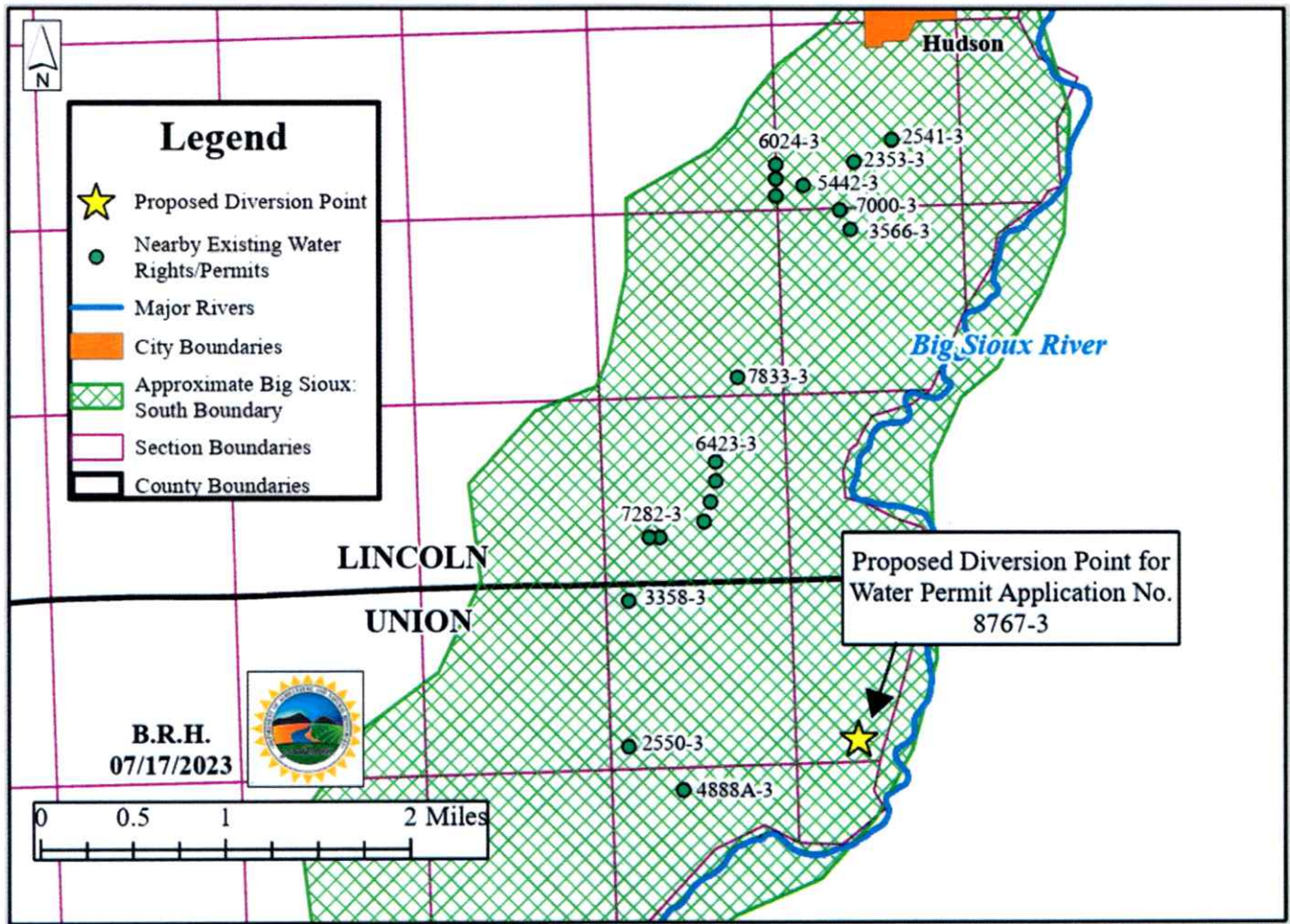


Figure 5: Map of the approximate Big Sioux: South aquifer boundary (modified from Hedges et al., 1982) showing nearby existing water rights/permits within approximately two miles around the proposed diversion point for Water Permit Application No. 8767-3 (Water Rights, 2023c).

Table 4: List of existing Big Sioux: South aquifer water rights/permits within two miles of the proposed diversion point as shown in Figure 5 (Water Rights, 2023c).

Permit No.	Name	Priority	Status	Use	Authorized Diversion Rate (cfs)	Acres
3358-3	Bill Boyer	12/23/1976	LC	IRR	1.29	90
7833-3	Bill Boyer	04/12/2013	PE	IRR	1.44	80
3566-3	James Cole	02/05/1977	LC	IRR	2	181
7000-3	James Cole	03/12/2008	LC	IRR	2	275
5442-3	Wayne Davelaar	04/18/1990	LC	IRR	0.54	38
2550-3	Richard Hamilton	02/20/1976	LC	IRR	1.78	120
2541-3	Ronald & Connie Hulshof	01/02/1977	LC	IRR	1.55	116
6064-3	Doug Kats	03/17/1998	LC	IRR	1.78	224
7282-3	Dianna Sorenson	12/08/2011	LC	IRR	1.78	140
4888A-3	Jett Boyer	05/05/1982	PE	IRR	1.14	80
2353-3	Donald Winterfeld	09/02/1975	LC	IRR	0.78	62
6144-3	Doug Winterfeld	05/17/1999	LC	IRR	0.78	62
6423-3	Poet Biorefining Hudson LLC	06/03/2003	LC	IND	1.78	N/A

The Big Sioux: South aquifer can vary between confined and unconfined conditions (Lindgren and Niehus, 1990). Based on water well completion reports and lithologic logs for observation wells near the proposed diversion point, the Big Sioux: South aquifer is expected to be unconfined near the proposed diversion point (SDGS, 2023; Water Rights 2023b and 2023c). Drawdown created by pumping a well generally does not extend far from the pumped well in an unconfined aquifer. In a confined aquifer, drawdown from pumping could extend a distance from the diversion point. The exact drawdown behavior of a well cannot be known without an aquifer performance test. Hydrographs for observation wells completed in the Big Sioux: South aquifer show no signs of being significantly impacted by drawdown caused by pumping, despite being located within four miles of several high-yield wells (assumed to be a well with an authorized diversion rate greater than 0.2 cfs) (Water Rights, 2023b and 2023c).

Within one mile of the proposed diversion point, the Big Sioux: South aquifer has a saturated thickness of approximately 20 to 25 feet (Water Rights, 2023d). This would generally allow for enough thickness for a pump to be placed 20 feet below the top of the aquifer, which is required for the well to be considered adequate under ARSD 74:02:04:20(6). Any drawdown as a result of the proposed diversion under this application is not expected to unlawfully impair nearby adequate wells. In Lincoln and Union Counties, there are no complaints on file with the DANR- Water Rights Program regarding well interference for adequate wells completed into the Big Sioux: South aquifer.

Considering the statutes SDCL 46-1-4 and 46-2A-9, the likelihood that the proposed diversion point is in an unconfined region of the Big Sioux: South aquifer, nearby saturated thicknesses of the aquifer of at least 20 feet, and the lack of well interference complaints for adequate wells completed into the Big Sioux: South aquifer (SDGS, 2023; Water Rights, 2023b, 2023c, 2023e), any drawdown created from the proposed diversion is not expected to cause unlawful impairment on existing water rights/permits or domestic uses from adequate wells.

CONCLUSIONS:

1. Water Permit Application No. 8767-3 proposes to appropriate up to 1,200 acre-feet of water annually at a maximum pump rate of 2.22 cfs from one pump to be completed into the Big Sioux: South aquifer, for the purpose of dewatering an open pit for industrial mining of sand and gravel. The site of interest is in Union County, approximately 16 miles east of Beresford, South Dakota.
2. Based on observation well data and the hydrologic budget, there is a reasonable probability that unappropriated water is available from the Big Sioux: South aquifer to supply the proposed appropriation.
3. There is a reasonable probability that the proposed diversion by Water Permit Application No. 8767-3 will not unlawfully impair adequate wells for existing water rights/permits and domestic uses.



Brittan Hullinger
Natural Resources Engineer I
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Reviewed by:



Adam Mathiowetz, PE
Natural Resources Engineer IV
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